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Geoscientific Model Development Discussions

Interactive comment on "Paleo calendar-effect adjustments in time-slice and transient climate-model simulations (PaleoCalAdjust v1.0): impact and strategies for data analysis" *by* Patrick J. Bartlein and Sarah L. Shafer

Anonymous Referee #3

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The authors present the software which can convert the standard output of PMIP models to the new, celestial, calendar. The authors believe that such a calendar is better than the standard (fixed day) one. This is my main disagreement with the authors and other reviewers. I simply do not believe that the celestial calendar is better (or worse) than the standard one.

The authors begin their paper from the statement that "there are two ways of defining month or seasons" (p. 1). This is of course not true since there is a myriad of ways to define months and seasons. Julian and Gregorian calendars are obvious examples.

For paleoclimate applications, there are many other options. For example, one can set the summer solstice to 22 June instead of setting vernal equinox to March 21, as is required by the PMIP protocols. In fact, fixing of the summer solstice would be more reasonable, at least for the Northern Hemisphere. While for the present day the calendar has absolute meaning since observational climate data used for model validations are aggregated according to the "official" months, for the analysis of past climate simulations in principle one is free which calendar to use. For model intercomparison, the only important requirement is that all models should use the same calendar. For comparison with paleoclimate proxies, any calendar is of limited use because the calendar is human invention and Nature has no idea about seasons or months. Therefore model/data comparison cannot be improved by choosing the "right" calendar. To the contrary, proper model/data comparison requires abandoning of any calendar and using climate characteristics which are independent of the choice of the calendar. Of course, ideally observed proxy records should be compared with the simulated ones.

Let's consider the advantages of using celestial calendar compare to the standard (fixed-day) one. For two special orbital configurations, namely, when summer solstice coincides with perihelion or aphelian ("warm" and "cold" orbits respectively) celestial calendar has one obvious advantage –the maxima and minima of insolation will always occur at the same days (90 and 270 days of celestial calendar) while under large eccentricity when using the standard calendar, the summer solstice (and maxima/minima of insolation) can deviate from 22 June by +-5 days. However, for the two "representative" months, January and July, the differences between the standard and celestial calendars (as shown by numerous figures in the Bartlein and Shafer manuscript) are rather small. These differences increase significantly during the transition months (August-November). Which of two calendars is better for these months? The simple answer is NONE because these months exist only in our imagination and I cannot see any sense in comparison, for example, September temperatures at present and 127 000 years ago. However, other workers may disagree with me and want to analyze climate change during spring or autumn. In this case, they have to realize that for these months, the celestial calendar has a serious problem even compare to the standard (fixed-day) one because it corrupts the most fundamental characteristics of the real world – time. For a high eccentricity, the days in the celestial calendar can be 10% shorter or longer than the real ones and, as the result, the beginning for example of celestial "October" can move back and forward compare to the summer solstice by more than 10 "real" days (Fig.2). At the same time, the internal time scales of the climate system do not depend on the orbital parameters and therefore the time lags between insolation and climate characteristics remain nearly constant in the real time, not in the celestial "days". Thus using of celestial calendar corrupts the physics of climate. It is noteworthy that in the paper by Kutzbach and Gallimore (1988) cited in the manuscript and where celestial calendar has been used, Kutzbach and Gallimore explicitly stated (page 820, first para) about the celestial calendar:

"The procedure, however, is mainly applicable to climate experiments that prescribe ocean and sea ice conditions, i.e., climate systems not having interactive components with significantly different lags in response to solar forcing".

Thus Kutzbach and Gallimore already 30 years ago clearly realized that corruption of absolute time is a serious problem. Surprisingly, modern authors seem to be unaware of this problem.

Above I only discussed the situation with two very specific orbital configurations –when summer equinox occurs in perihelion or aphelion (like that at 126 ka or 116 ka). What about an arbitrary Earth's orbit? For any arbitrary orbit, the only advantage of the celestial calendar disappears because maxima and minima of insolation at different latitudes do not coincide anymore with the solstices and can deviate from them by up to one week, i.e. as much as they can deviate from 22 June and 22 December in the standard calendar.

By saying that, I want to make it clear that I am not against using several different calendars. This at least helps to understand that at the orbital time scales, things

like "spring" or "October" do not have any meaning. But to be useful, the manuscript under consideration should not make false impression that it presents The Solution for the Calendar Problem and that Celestial Calendar is the right one. I believe, the manuscript requires a thorough discussion of problems and limitations of any calendar applied to the analysis of model results.

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